Saskatchewan
Agriculture

# Annual Report 1984-85

## Saskatchewan Agriculture

## The Saskatchewan Agricultural Research Fund

# Saskatchewan Agricultural Research Fund

To His Honour,
The Honourable Frederick W. Johnson
Lieutenant Governor of the Province
of Saskatchewan

Sir:

I have the honour to submit the Sixth Annual Report of the Saskatchewan Agricultural Research Fund for the period April 1, 1984 to March 31, 1985.

I have the honour to be Sir,

Your obedient servant
Grant Devine
Premier and Minister of Agriculture

# The Saskatchewan Agricultural Research Fund

Honourable Grant Devine
Premier and Minister of Agriculture

Dear Sir:

It is my pleasure to present the Sixth Annual Report of the Saskatchewan Agricultural Research Fund for the period April 1, 1984 to March 31, 1985.

Respectfully submitted

J.L. Drew
Deputy Minister of Agriculture

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Respectfully submitted

S. Ann Barnsley
Chairman of the Saskatchewan
Agricultural Research Fund

## Introduction

The Saskatchewan Agricultural Research Fund was established by the June 15, 1979 proclamation of The Agricultural Research Funding Act. The Fund consists of such money as may be appropriated annually by the Legislature, the annual earned interest, plus other money which may be transferred into the Fund by the Lieutenant Governor-in-Council. A portion of the funds are made available annually to individuals, corporations, co-operatives, associations or other organizations for the purpose of agricultural research in the Province. Applications are invited annually from interested parties. Initial appropriation for 1979-80 fiscal year was $3.25 million.

The Fund is administered by a producer-represented Board which has the authority to make grants, loans or guarantees or enter into agreements or contracts respecting assistance provided to persons. The Board as appointed by the Lieutenant Governor-in-Council, consists of seven persons, including five practising agricultural producers and two agricultural research professionals. The Chairman and Vice-Chairman of the Board are designated by the Lieutenant Governor-in-Council. The Deputy Minister of the Saskatchewan Department of Agriculture serves as an advisor to the Board. The Board is responsible to the Minister of Agriculture.

## Activities 1984-85

In 1984 sixteen applications for new projects were approved for a total of $236,600. Of the twelve ongoing projects, two in their third year of research received a total of $41,000 while the ten second year projects were granted a total of $167,800. The Board reviewed 74 applications requesting a total of approximately $1.4 million.

At the end of 1984-85 twenty projects were in progress. Statements including the objectives and the potential impact of these projects are printed in this report. Executive summaries of the seventeen projects completed during 1984-85 are also provided in this report. More detailed reports on both ongoing and completed projects are available from the Board secretary or the individual grantees.

The financial statements of the Fund have been audited by the Provincial Auditor. These statements are presented in the final section of this report.

The Board extends their appreciation to all who submitted applications in 1984. The degree of interest in the Fund is encouraging as is the potential benefit to agriculture from these types of proposals.

# Saskatchewan Agricultural Research Fund Board 1984-85

| | |
|---|---|
| CHAIRMAN: | **Mrs. Ann Barnsley**<br>Box 625<br>BALCARRES, S0G 0C0 |
| VICE-CHAIRMAN: | **Dr. J. Milton Bell**<br>Department of Animal<br>and Poultry Science<br>University of Saskatchewan<br>SASKATOON, S7N 0W0 |
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| MEMBER: | **Mr. Henry Martynse**<br>Box 1208<br>WYNYARD, S0A 4T0 |
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| MEMBER: | **Mr. Richard Westman**<br>STEWART VALLEY, S0N 2P0 |
| ADVISOR: | **Mr. Jack Drew**<br>Deputy Minister<br>Saskatchewan Agriculture<br>3085 Albert Street<br>REGINA, S4S 0B1 |
| SECRETARY: | **Ms. Brenda Machin**<br>Saskatchewan Agriculture<br>3085 Albert Street<br>REGINA, S4S 0B1 |

## Distribution of Projects and Funding by Program Area

| Program Area | Awarded 1983-84 | Awarded 1984-85 | % of Total Awarded 1983-84 | % of Total Awarded 1984-85 | Assigned 1983-84 | Assigned 1984-85 | % of Total Assigned 1983-84 | % of Total Assigned 1984-85 |
|---|---|---|---|---|---|---|---|---|
| Cereal Crops | 3 | 3 | 9.7 | 10.7 | 38,500 | 40,500 | 8.7 | 9.1 |
| Special Crops | 5 | 4 | 16.1 | 14.3 | 57,900 | 54,500 | 13.1 | 12.2 |
| Forage Crops | 2 | 2 | 6.4 | 7.1 | 45,300 | 45,000 | 10.2 | 10.1 |
| Horticultural Crops | 3 | 3 | 9.7 | 10.7 | 19,800 | 20,900 | 4.5 | 4.7 |
| Ruminants | 4 | 5 | 12.9 | 17.8 | 75,800 | 80,300 | 17.1 | 18.0 |
| Non-Ruminants | 7 | 4 | 22.6 | 14.3 | 110,300 | 99,200 | 24.9 | 22.3 |
| Land, Air, Water | 2 | 4 | 6.4 | 14.3 | 27,000 | 61,000 | 6.1 | 13.7 |
| Energy, Equipment | 1 | 1 | 3.2 | 3.6 | 11,000 | 15,000 | 2.5 | 3.4 |
| Socio-Economics | 2 | 1 | 6.5 | 3.6 | 37,000 | 15,000 | 8.4 | 3.4 |
| Miscellaneous | 2 | 1 | 6.5 | 3.6 | 20,000 | 14,000 | 4.5 | 3.1 |
| TOTAL | 31 | 28 | | | 442,600 | 445,400 | | |

# Approved Projects 1984

| Title | Research Manager | Institution | 1984 Grant |
|---|---|---|---|
| **Cereal Crops** | | | |
| Biology and Control of the Wheat Blossom Midge in Saskatchewan | J.F. Doane | Agriculture Canada Research Station Saskatoon | $13,500 |
| The Effect of Growth Regulators on Winter Survival, Lodging and Yield of Norstar Winter Wheat & Muskateer Fall Rye | L.V. Gusta | Crop Development Centre Univ. of Sask. | 15,000 |
| Target and Penetration of Aerially Applied Insecticide Spray for Wheat Midge Control | K. Yoshida | Saskatchewan Research Council Saskatoon | 12,000 |
| **Special Crops** | | | |
| Scentless Chamomile Control Program | G. Bowes | Agriculture Canada Research Station Regina | 9,400 |
| Development of a Bleaching Resistant, Green Cotyledon Dry Pea for Saskatchewan | A.E. Slinkard | Crop Development Centre Univ. of Sask. | 11,700 |
| Canola Press Cake as a High Energy, High Protein Animal Feed | J.M. Bell | Dept. of Animal and Poultry Science Univ. of Sask. | 24,000 |
| A Re-evaluation of Seed Treatments for Pulse Crops | R.A.A. Morrall | Dept. of Biology Univ. of Sask. | 9,400 |
| **Forage Crops** | | | |
| Fertilizer Requirements of Grazed Seeded Grass Pastures and the Effects of Nutrition and Production of Beef Cattle and Subsequent Performance on Winter Feed | R.D.H. Cohen | Dept. of Animal and Poultry Science Univ. of Sask. | 30,000 |
| Renovation of Pastures by Direct Seeding | J. Waddington | Agriculture Canada Research Station Swift Current | 15,000 |
| **Horticultural Crops** | | | |
| Inhibitory Effects of Green Foxtail (Setaria virdis L.) on Onion Plants | D.H. Dabbs | Dept. of Horticulture Science Univ. of Sask. | 12,000 |
| Using Etiolation as a Pre-Treatment in the Propagation of Saskatoon Softwood Cuttings | S.H. Nelson | Dept. of Horticulture Science Univ. of Sask. | 4,200 |
| Vegetable Varietal Trial | C.O. Green | Prairie Produce Limited Outlook | 4,700 |

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|---|---|---|---|
| **Ruminants** | | | |
| Intensification of Sheep Production Under Prairie Conditions | N.C. Rawlings | Western College of Veterinary Medicine Univ. of Sask. | 30,000 |
| Study of a Bleeding Disorder in Simmental Cattle | G.P. Searcy | Western College of Veterinary Medicine Univ. of Sask. | 15,800 |
| Evaluation of Protein Status of Lactating Dairy Cows | D.A. Christensen | Dept. of Animal and Poultry Science Univ. of Sask. | 17,000 |
| To Evaluate Practical Post-Partum Nutritional and Drug Management in Controlled Breeding of Beef Cows | D. McCartney and A. Robertson | Agriculture Canada Research Station Melfort | 4,000 |
| Electronic Identification of Livestock | G.C. Zoerb and J.W. McLean | Dept. of Agric. Engineering Univ. of Sask. | 13,500 |
| **Non-Ruminants** | | | |
| Dietary Enzyme Supplementation as a Method of Improving the Nutritional Value of Cereal Grains | H.L. Classen | Dept. of Animal and Poultry Science Univ. of Sask. | 27,000 |
| Swine Barn Ventilation | E.M. Barber | Dept. of Agric. Engineering Univ. of Sask. | 36,000 |
| Effects of Combination of Feed Quantity, Feed Quality and Low Air Temperatures on Post Weaning Diarrhea in Pigs | G.I. Christison | Dept. of Animal and Poultry Science Univ. of Sask. | 13,500 |
| Abnormal Behavior of Early Weaned Piglets | N.J. Lewis | Dept. of Animal and Poultry Science Univ. of Sask. | 22,700 |
| **Land, Air, Water** | | | |
| Groundwater Irrigation | J.A. Gillies | Dept. of Agric. Engineering Univ. of Sask. | 11,000 |
| Use of Leonardite for Soil Improvement | Z. Abouguendia | Saskatchewan Research Council Saskatoon | 10,000 |
| The Determination of S. Triazine Levels in Soil by Instrumental Analysis and Bioassay | R.B. McKercher | Dept. of Soil Science Univ. of Sask. | 20,000 |
| Mineralogy, Morphology and Dynamics of Salts in Agricultural Soils in Saskatchewan | A.R. Mermut | Dept. of Soil Science Univ. of Sask. | 20,000 |

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|---|---|---|---|
| **Energy, Equipment** | | | |
| Comparative Efficiency of New Low Volume Applicators for Use with Herbicides | R. Ashford | Dept. of Crop Science and Plant Ecology Univ. of Sask. | 15,000 |
| **Socio-Economics** | | | |
| The Comparative Advantage of Wheat Production in Saskatchewan | W.H. Furtan | Dept. of Agric. Economics Univ. of Sask. | 15,000 |
| **Miscellaneous** | | | |
| High Temperature Fermentation of Straw | D.E. Caldwell | Dept. of Applied Microbiology and Food Science Univ. of Sask. | 14,000 |

# Summaries of Completed Projects

## Cereal Crops

**"The Role of Supercooling in Herbaceous Plants in Preventing Frost Damage"**

L.V. Gusta, B.J. O'Connor — $51,725
Crop Development Centre — 3 years
University of Saskatchewan

Cultivars of commonly grown wheat, barley, oats, rape and mustard were evaluated for frost tolerance and the ability to supercool at sub-zero temperatures. Eight cultivars of both wheat and barley and six cultivars of oats were used in these tests. At the two-leaf stage, most of these cereals could tolerate a frost of -8 degrees C for one hour. On the average, the wheat cultivars were more frost tolerant than barley or oats. A frost of -6 degrees to -8 degrees at the early dough stage reduced the yield and kernel weight, and germination of the harvested seeds. Oats were more sensitive to frost than wheat or barley at the early dough stage.

Rape and mustard plants are the most frost sensitive at the cotyledon stage of growth. However, plants at the 4 to 6 leaf stage can tolerate temperatures as low as -4 degrees to -6 degrees for one hour. Plants grown at cool temperatures develop 1 to 2 more degrees of frost tolerance than plants grown at 20 degrees C or warmer. A frost of -4 degrees C at the 1 to 3 leaf stage delays bolting and flowering of mustard and canola. However, at the 4 to 6 leaf stage, a frost of -5 degrees to -6 degrees C is required to delay bolting and flowering.

A frost of -4 degrees C at the time of flowering results in a dramatic yield loss.

Very low levels of ice nucleating bacteria were found in rape and mustard throughout the growing season. Although there were low levels of ice nucleating bacteria, the leaves froze at -5 degrees C throughout the growing season. These results suggest that rape and mustard may have intrinsic nucleating agents.

Oat leaves had the highest population of ice nucleating bacteria of the cereals tested. The highest population of ice nucleating bacteria were found in mid- to late-summer.

**"Influence of Nitrogen Fertilizer on the Agronomic Performance and Quality of 'Stubbled-In' Winter Wheat (Triticum Aestivum L.)"**

D.B. Fowler — $30,000
Crop Development Centre — 2 years
University of Saskatchewan

Nitrogen fertilizer is one of the major costs associated with stubbled-in winter wheat production. Therefore, to insure that returns from N fertilizer are maximized, accurate information is required on nitrogen response curves as they are influenced by timing of nitrogen application, fertilizer formulation and environmental conditions. To obtain this information nitrogen fertilizer trials were conducted on winter wheat fields of co-operators at Clair, Kindersley, Watrous, Strasbourg and Saskatoon in 1982-83 and 1983-84.

Uptake studies showed a gradual decrease in nitrogen concentration in the stems and leaves of winter wheat plants as the growing season progressed. In contrast, nitrogen concentration of the heads remained relatively constant from emergence to maturity. The concentration of nitrogen in the mature seed was greater than in the remainder of the head. When soil nitrogen levels were low, increased nitrogen fertilizer increased the dry matter yield and plant nitrogen per hectare. These differences were clearly evident as early as the four leaf stage and carried through to maturity.

Nitrogen concentration of the plant tissue was not influenced by the amount of fertilizer nitrogen applied.

Responses to broadcast urea were found to be much more erratic than for 34-0-0. These results are consistent with earlier scientific reports for other cropping situations. However, considerable difficulty in quantifying these losses can be expected.

Preseed banding treatments gave the most dependable N responses in both 1982-83 and 1983-84. However, except for extremely dry springs, the response to spring 34-0-0 was equal to the banding treatments and the physical problems associated with banding were avoided. Earlier results with 34-0-0 strongly favored early spring over fall N applications further emphasizing the difficulties in defining an optimum fertilizer management scheme.

These studies have emphasized the importance of nitrogen fertilizer in the successful production of winter wheat. They also demonstrate the complexities of the nitrogen cycle and the difficulties in providing a formula for maximizing nitrogen responses. Environmental conditions, especially moisture, are not a constant and, as a result, no single program for nitrogen fertilization can be recommended.

**"Variability in Spring Wheat for Rapid Germination and Seedling Vigor at Low Temperatures"**

G.R. Hughes, D.T. Gehl — $15,871
Dept. of Crop Science & Plant Ecology — 2 years
University of Saskatchewan

Varietal differences in time to germination and seedling emergence were observed in low temperature (6-12° C) laboratory studies involving 30 spring wheat varieties of diverse origin. Varieties differed by as much as 26 h for germination and 30 h for emergence. There was only a partial relationship between germination and emergence times. This was due to differences in growth rate during the period between germination and emergence. Differences were found in rate of coleoptile elongation, root development and in the efficiency with which the stored food reserves in the seed were used in pre-emergence seedling growth. These differences tended to be independent of the seed germination rate.

Neepawa, Columbus and Benito were among the slowest varieties to emerge in both laboratory and field studies. There were characterized by both slow germination and slow growth rates prior to emergence. Park, however, germinated slowly but was among the fastest to emerge due to a rapid rate of coleoptile elongation.

Similar differences in emergence were found in field studies but were of smaller magnitude than observed in the laboratory studies. A low relationship did exist between rapid emergence and early seedling growth. However, the rate of subsequent plant development was independent of emergence rate. Nor could any association be found between germination and emergence rates and time to heading or maturity. There were varietal differences in post-emergence development rates and in the degree-day (0° C base) requirement to reach specific development stages.

The prime objective of this study was to establish whether sufficient differences existed in spring wheat to warrant development of varieties capable of rapid germination and seedling establishment in cool soils. Such conditions are frequent in the northern wheat growing areas of Saskatchewan and in fields with a heavy trash cover. The results indicate that differences do exist and that the currently used varieties are poorly suited to seeding into cool soils. The development rates during germination, germination to emergence and post-emergence stages of growth tend to be unrelated. Therefore it will be necessary to combine rapid germination and rapid coleoptile growth rates from different varieties to achieve maximum reduction of the pre-emergence period. Using the rates measured in this study, a reduction of 2-3 days in the total growing period could be achieved without changing the post-emergence growth period and, consequently, the yield potential.

## Special Crops

**"Evaluation of Canola Products and By-Products"**

J.M. Bell and M.O. Keith — $20,000
Dept. of Animal & Poultry Science — 1 year
University of Saskatchewan

The funds granted for this project were used to provide supplementary support for several projects that received their major funding from other agencies such as NSERC and the Canola Council of Canada.

Contamination of canola seed with wild mustard has been a serious problem, especially in northeastern Saskatchewan. This has led to interest in growing triazine-tolerant varieties that were developed at the University of Guelph, but until better yielding varieties of this type are available it is probable that mustard contamination will remain a problem and some samples may be found unsuitable for crushing. Mustard seed is high in both erucic acid and glucosinolates, the two problem factors that led to the development of canola varieties of rapeseed.

Using canola seed containing about 30% wild mustard, a series of swine grower diets containing 0, 3, 6 and 9% wild mustard seed were formulated and fed to growing-finishing pigs. In addition the diets were fed as meal and as pellets, and ground and ground-ammoniated mustard seed were also compared. It was found that the pigs performed well on all levels of ground mustard seed indicating that such material can be fed successfully to pigs. Ammoniation improved daily gains but adversely affected the efficiency of feed utilization, indicating probable damage to essential amino acids, especially lysine. Pelleting improved daily gains and feed efficiency.

Two new canola meals, Westar and Triton, were evaluated for swine feeding. Westar was found to be very similar to Tower in terms of digestible energy and digestible crude protein but Triton was slightly more digestible and possessed more digestible protein (42.3 vs 38.6%) than Westar, based on 1983 field scale, commercially crushed test material.

The digestibility of lentils unsuitable for the food trade on account of ascochyta was determined. Their digestible energy value was about equal to that of average barley but the digestible crude protein (16.3%) was about twice that of barley. Feeding trials on lentils have been completed and are to be reported elsewhere when the results are fully evaluated.

Research continued on the effects of canola meal on mineral utilization in pigs. This concern relates to the relatively high phytate content of canola meal and its ability to combine with calcium, zinc and some other essential minerals thereby reducing their availability to the animal. A series of laboratory tests, rat tests and swine tests have been completed except for the statistical work and evaluation of results.

These experiments have shown that canola seed badly contaminated with wild mustard can be fed successfully to pigs and, based on previous work with frost-damaged canola seed, would probably be worth about 50% more than average barley. The feeding value of Westar and Triton canola meals were established for use in swine rations. Lentils were shown to have an energy value similar to barley and to have about twice the barley level of digestible protein.

**"Evaluation of Four Oilseed Sunflower Hybrids Under Three Fertilizer Regimes at Four Locations in Saskatchewan"**

G.L. Hnatowich, D.C. Campbell — $24,400
Saskatchewan Wheat Pool — 2 years
Regina

Five replicated field experiments were established to evaluate the suitability of different oilseed sunflower hybrids to various areas of the province and to study sunflower response to different nutrient levels and growing conditions. Results were obtained at only three of the five locations.

Fertilizer nitrogen applications had no effect on the seed yield of sunflower. Seed yields were reduced as a result of moisture stress occurring at anthesis consequently fertilizer responses may have been restricted by environmental conditions. At all locations fertilizer nitrogen reduced the oil content of the seed, banded nitrogen treatments causing a greater reduction than broadcast treatments. Generally, seed weights, plant height and head diameter were not affected by nitrogen fertilization. At one location, Watrous, fertilized treatments reduced the time to 50 and 100% flowering. Enhanced dry matter production followed by subsequent heat and moisture stress may have promoted earlier floral initiation for fertilizer treatments at this location. No differences occurred between fertilized and nonfertilized with respect to days to physiological maturity.

The five hybrids evaluated differed agronomically from one another at each location, individual hybrids also differed from location to location. No hybrid was the highest yielding at more than one location. The hybrid IS7000 was the highest in oil percentage at all locations. 894 was the lowest at two locations. The largest heads were produced by 894 however this hybrid had the lightest seed weight. Sun M20 and Morden 21 produced the smallest heads but had the highest seed weights. Sun M20 produced the tallest plants at all locations. The earliest maturing hybrids were Sun M20 and Morden 21, flowering up to ten days earlier and maturing as much as 16 days earlier than did IS7000, D0704XL and 894.

**"An Evaluation of Seedcups (Seed Metering Devices) for Seeding Grain Legumes"**

G.G. Rowland — $39,970
Crop Development Centre — 3 years
University of Saskatchewan

Until the 1970's grain legume production in Saskatchewan was limited to field pea *(Pisum sativum)*. However, since 1970 lentil *(Lens culinaris)*, faba bean *(Vicia faba)* and broad bean *(V. faba)* have been grown. In addition the Crop Development Centre has conducted research on chickpea *(Cicer arietinum)* with the aim of introducing this crop to Saskatchewan.

Seeding equipment used by farmers in Saskatchewan is very well suited for small cereal grains but difficulties can arise when using this equipment for seeding grain legumes. While problems with lentil were minimal, farmers complained that their drills or discer seeders were badly cracking faba bean seed and not distributing the seed evenly. Since chickpea and small-seeded broad beans are even larger and more irregular in their shape than faba bean, it is anticipated farmers will have similar problems in sowing these crops.

The problem of seed cracking and poor seed distribution are primarily due to the seed metering devices (seedcups) used in these drills and discer seeders. The types of drills and discer seeders used in Saskatchewan are quite varied in type and varieties of seedcups used. Recommendations are not available to Saskatchewan farmers as to what seed material system might work best for a particular grain legume and it was for this reason that this study was undertaken.

The 1984 study was mainly a repeat of the 1983 field tests. In all 16 types of seedcups were evaluated on lentil, pea, faba bean, chickpea and broad bean. For each crop-seedcup combination a 15m row was sown in the field and this was replicated three times. The amount of seed going into each row was determined and the stand uniformity rated.

Based on the 1983 and 1984 results it appears that most of the seedcups tested will do an adequate job with lentils but that more difficulties are encountered with larger seeds. The following is a list of some seedcups that were most consistent in their performance in this year's testing and some comments on each.

CCIL EXTERNAL FORCE FEED. This seedcup was very consistent with faba bean and gave acceptable uniformity over all crops. However, it did not perform well in the 1983 test except for lentils.

DUNCAN EXTERNAL FORCE FEED. As with the 1983 test its peformance was best with pea.

INTERNATIONAL HARVESTER EXTERNAL FORCE FEED. Its seed feeding was very consistent with pea and as with the 1983 results is the best of the cups with the Hoozier design.

JOHN DEERE INTERNAL FORCE FEED (double run-large). This was very consistent with chickpea but was not acceptable for the broad bean.

LILLISTON-MELROE EXTERNAL FORCE FEED. Generally a feed wheel could be found that would do a satisfactory job with a particular crop. However, as with the 1983 experiments no feed wheel was suitable for pea. Consistent seed delivery was obtained with the course wheel in chickpea and broad bean.

MASSEY-FERGUSON INTERNAL FORCE FEED. This system fed seed of the lentil and pea very consistently. The small run gave acceptable field uniformity for lentil and the large run for pea. The 1983 results were not as positive for this seedcup.

MORRIS EXTERNAL FORCE FEED. As was the case with the 1983 study a feed wheel could be found that would do a satisfactory job with any of the crops tested. The bean wheel with faba bean; the custom bean wheel with faba bean, chickpea and broad bean; and the normal grain wheel with pea, faba bean and chickpea all gave consistent seed feeding.

Prior to this study little or no information on seeding equipment was available to farmers contemplating growing a pulse crop in Saskatchewan. This study will now make it possible to include some recommendations on seed drills in extension publications on pulse crops. This should help farmers to avoid problems in seeding pulse crops. It should also help to improve stands of pulse crops, leading to better weed control and seed yield.

## Forages

**"An Evaluation of Winter Hardiness in Saskatchewan Forage Grasses"**

A.E. Limin and D.B. Fowler — $40,500
Dept. of Crop Science & Plant Ecology — 3 years
University of Saskatchewan

The research was designed to provide an objective cold hardiness rating of Saskatchewan grown forage grasses. Prior to this project very little information had been collected on the cold tolerance of forage grasses grown in the province. To determine the risk of winter-kill when fall seeding is considered, the cold hardiness of fall sown seedling grasses was also compared to the cold hardiness of established spring sown grasses.

The most cold-hardy variety of winter wheat, 'Norstar', and the very cold tolerant winter rye variety 'Puma' were used in all freeze tests as standards for comparison. When fall sown the least cold hardy forage grasses, orchard grass and reed canary grass, were considerably less cold hardy than Norstar winter wheat. Fall seeding of these species would not be recommended because of the high risk of winter-kill. Many other varieties would need adequate snow-cover to ensure winter survival if fall sown. Several of the most hardy seedling varieties could survive with minimal snow-cover. However, none of the grass varieties which were tested at the seedling growth stage were more cold hardy than Puma rye.

Plant crowns from the established stands were on average approximately 6 degrees C more cold hardy than crown tissue of the same varieties at the seedling growth stage. When spring sown, even the least cold-hardy varieties were similar in cold hardiness to Norstar. Once established, many other varieties had cold hardiness levels similar to, or greater than, Puma rye.

In general, based on cold hardiness ratings, forage grasses should preferably be sown in the spring to reduce the danger of first year winter-kill. If fall seeding is considered, most varieties would require a snow-cover equal to or greater than what would be needed to ensure survival of winter wheat. The ranking of varieties on the basis of cold hardiness, relative to Norstar winter wheat and Puma winter rye, should provide a guide to varietal selection and management for maximum winter survival.

## Horticultural Crops

**"Vegetable Variety Trials"**

C. Oliver Green — $11,050
Prairie Produce Ltd. — 3 years
Outlook

Since 1982 varieties of broccoli, cabbage, winter cabbage, sweetcorn, green peppers, carrots and strawberries have been evaluated for various years in either single row replicated trial or field scale methods at Outlook to determine the better varieties suited to local growing conditions under irrigation.

Varieties are evaluated for yield and quality as well as suitability for commercial production. Some results to date have given clear indication of the better varieties while others are only preliminary.

For broccoli both Green Duke and Bravo have proven to be the better performers.

Only self-blanching varieties of cauliflower have been considered since commercially it would be uneconomical to tie leaves to ensure white curd. Snowcrown is the earliest variety but harvest timing is more critical since it lacks some of the self-blanching character. Snowball X, Y Improved, and Olympus all performed well.

The variety Hybrid Red Head was clearly the better variety of Red Cabbage while Winter Keeper and Safe Keeper were the better yielding varieties of winter cabbage. They do not, however, retain their green color in storage while Houston Evergreen did have better color retention and consequently would continue to be the recommended variety to grow.

both Aztec and Golden Beauty sweet corn performed equally well on field scale evaluations but since Aztec has the cobs positioned higher on the stalk permitting easier handpicking, it would be the preferred variety for commercial production.

Results for cantaloupe, watermelon, green pepper and carrots are only preliminary and no clear varieties can be recommended.

Summit, Classic, Burpee Hybrid and Alaska cantaloupe look good with Alaska being clearly earlier maturing. Sweet Favorite watermelon was fair and Hicolor 9 carrots looked promising.

Economically the "in season" unloads of the above vegetables into the Regina and Saskatoon market in 1983 was 6,719,000 pounds representing a farmgate value of $1,169,580. Of those unloads only 1,812,000 pounds valued at $259,160 came from Saskatchewan producers.

Of all "in season" vegetable unloads into Regina and Saskatoon, excluding potatoes only 11.8% (in 1983) came from Saskatchewan producers. There were 24,146,000 pounds of "in season" vegetables unloaded in Regina and Saskatoon in 1983 of which only 2,850,000 pounds came from Saskatchewan producers.

This means that 21,296,000 pounds of fresh vegetables or 532 semi loads which could have been grown here were imported from other provinces, and primarily from the United States. Wholesalers have indicated that Regina and Saskatoon represent about two-thirds of the Saskatchewan market so that the net effect has meant Saskatchewan consumers in 1983 spent in the neighborhood of $6,000,000 for imported fresh vegetables.

In order to replace those imports with domestic produce requires continued research and evaluation of varieties best suited to local conditions.

## Ruminants

**"An Evaluation of the Effects on Livestock Accidentally Ingesting Low Levels of Pesticides and Herbicides"**

R.K. Chaplin — $9,800
Western College of Veterinary Medicine — 1 year
University of Saskatchewan

Livestock often become exposed to agricultural chemicals by accident. Although cases of poisoning occur which result in illness and often death it is likely many more cases occur and go unnoticed due to a lack of symptoms.

The intention of the present study concentrated on determining the level of various chemicals necessary to significantly affect digestion and hence performance in livestock. In addition once a chemical was ingested it was necessary to determine approximately how long the effect remained.

To begin the evaluation a laboratory test was designed to prevent the animal from becoming exposed to the chemicals directly. Using sheep with a surgically implanted fistula (opening) into the rumen (stomach), samples of rumen contents were removed, added to a flask containing feed with digestion evaluated by the amount of gas produced. By adding the chemical to the flask its affects on digestion could be evaluated.

In this study four organophosphate, two organochlorine and one carbamate insecticides, one fungicide and four herbicides were examined. By using published minimum toxic doses (MTD) for each chemical it was possible to determine whether or not the rumen was more sensitive than the animal to a given chemical. Of the twelve chemicals tested Pentachlorophenol or the wood fungicide, Pentox was found to be 150 times more toxic to the rumen than to the animal. As an example, should a sheep chew on wood treated with Pentox, 30 g of the chemical would need to be ingested to affect the animal whereas only 200 mg (1/150) would have a detrimental affect on digestion. The other chemicals which were more toxic to the rumen were Lindane (2X), Methoxychlor (17X), Trichlorfon (4X) and Paraquat (3X). Roundup was difficult to evaluate as the MTD was an approximation. The rumen however appears to be about 20X more sensitive to Roundup than does the animal.

The second part of the study evaluated the length of time it took the rumen activity to recover once insulted by the presence of these chemicals. By adding a single dose at a fraction of MTD to the rumen, fluid was removed each hour to monitor the effect. Ronnel, an organophosphate insecticide used in backrubbers reduced activity for about 24 hours. Methoxychlor an organochlorine insecticide reduced activity 72 hours. It is obvious that if low doses of these chemicals were consumed often rumen activity and therefore animal performance could be severely affected without the animal showing symptoms of toxicity. At the present time it has been impossible to determine if the carrier substances in the pesticide and herbicide solutions are as toxic or worse than the chemicals in question.

**"Superovulation in the Cow: Effect of Day of Cycle"**

R.J. Mapletoft — $57,000
Western College of Veterinary Medicine — 3 years
University of Saskatchewan

As part of an ongoing research program with the ultimate objective of improving the efficiency of bovine embryo transfer techniques, a study was designed to determine whether ovulatory response to follicle stimulating hormone (FSH) in cows and heifers would differ when treatment was initiated at different times during the estrous cycle. The currently accepted practice is to commence treatment on days 8 to 12 of the cycle (day 0 = the

day of estrus or heat). Follicle stimulating hormone exerts its effect by stimulating the growth of large numbers of follicles in the ovaries, while at the same time decreasing the amount of follicular degeneration which would normally occur during the cycle in the untreated cow. Follicles capable of responding to FSH stimulation are most abundant in the ovaries of the cow from days 0 to 5 and from days 9 to 13 of the cycle. It was hypothesized that response to FSH treatment may also vary during the cycle, due to differences in the follicular populations at the time of FSH treatment.

In Experiment I, treatment of 42 mature Holstein heifers was initiated on either day 3, 6, 9 or 12 of the estrous cycle. Blood samples were taken to determine hormone concentrations (progesterone, estradiol-17B and luteinizing hormone) during the treatment period. Unfertilized eggs (ova) and fertilized eggs (embryos) were flushed from the reproductive tracts and numbers of ovulations (corpora lutea = C1) were determined at slaughter seven days after estrus. Heifers in which treatment was initiated on day 9 yielded the highest average numbers of ovulations (33.3) and embryos (13.3). Developmental stages and quality of embryos, determined microscopically, did not differ among treatment groups. Hormone profiles allowed investigation of the possible reasons for failure of superovulation in individual animals but no differences among groups in hormone profiles were determined. In Experiment II, 39 culled cows of various breeds were treated with FSH on either day 5, 7, 9 of the estrous cycle. Average numbers of ovulations did not differ among treatment groups. Results indicate that although acceptable superovulatory response can be obtained after treatment early in the estrous cycle, there is some variation in response at different times of the cycle.

Improvement of bovine embryo transfer procedures will reduce costs and increase its usefulness in the production of offspring from cows of superior genetic economic worth.

## Non-Ruminants

**"The Roles of Solar and Pheromonal Cues in the Orientational Ability of THAMNOPHIS RADIX HAYDENI During Fall Migration"**

D.M. Secoy, P. Lawson — $12,500
Biology Dept. — 3 years
University of Regina

The ability of the plains garter snake, THAMNOPHIS RADIX HAYDENI to use solar cues as orientation guides for homing was examined. It is their habitual use of certain buildings as denning sites which often results in their status as pests. Snakes were displaced from the hibernaculum area in the fall and tested in circular arenas. Snakes demonstrated the ability to orient along the homeward axis using only solar cues. Differences in orientation patterns between different populations suggested the involvement of a distance effect. Furthermore, these patterns suggest the possible use of polarized light as a specific orientation guide.

The influence of pheromone trails on solar orientation was also examined. The presence of both potential orientation cues resulted in either a loss of directedness or the selection of a different compass direction. Both a distance effect and an age effect appear to be involved, suggesting that solar cues function in orientation at greater distances from the den, while pheromone trails become more important at closer range. Newborns, which remain closer to the den than do adults, may have a shorter effective range for this shift.

**"The Economics of Wheat and Grain: Protein Ratios in Growing-Finishing Hog Rations"**

Robert Blair, B. Rakshit, K.A. Rosaasen and V.J. Racz — $50,000
Dept. of Animal & Poultry Science — 2 years
University of Saskatchewan

The corn-soybean meal-hog complex is often regarded as the standard against which hog production elsewhere is measured. In areas such as Western Canada where barley and sometimes wheat comprise the available grains, and where pig breeds and grading standards differ from those of the U.S.A., it is possible that these factors may affect our competitive position, especially in relation to U.S. production.

In order to address these issues two feeding trials were undertaken to compare performance on a corn-soy diet with that on a barley-wheat-soy diet, a barley-soy diet of lower digestible energy level and a barley-soy diet having protein reduced to maintain the same digestible protein: digestible energy level as in the corn-soy diet. In addition, the use of acidulated fatty acids from canola oil refining was tested as a means of increasing the digestible energy level of barley-soy diets, and in the finishing period, comparisons were made of barley versus barley-wheat diets as they affect growth and feed efficiency as well as carcass quality.

A total of 432 crossbred Lacombe x (Landrace x Yorkshire) pigs were fed from 20-22 kg initial weight to 100 kg slaughter weight in pens of 6 or 12 pigs per pen. Similar pigs were used in concurrent digestibility trials.

In the first experiment corn and wheat diets permitted about 13% faster daily gains during the growing period (20-50 kg) than occurred with barley diets but the daily feed intakes were similar for all diets. Corn-fed pigs required 2.48 kg feed/kg gain compared with barley-fed pigs at 3.03 and wheat at 2.74. The low protein barley diet allowed good performance.

During the finishing period pigs grew equally well on all diets. Efficiency of feed utilization on the corn diet was about 7% better than on the barley diet. Pigs fed the low protein barley diet performed as well as those fed the barley diet containing the recommended (NRC) level of protein.

In the overall period (20-100 kg) corn-fed pigs displayed the highest daily gain and best feed efficiency. Corn and wheat diets resulted in 9% less feed being required than with barley diets. However, corn-fed pigs had fatter carcasses than those fed barley and obtained a lower carcass index thereby yielding about 3% lower carcass

return to the producer. Thus, the better feed efficiency of the corn diet must be modified by any price differential associated with corn versus barley, plus a reduction in carcass returns.

The digestibility of energy was higher for corn and wheat diets than for barley diets, which accounts for the better efficiency of feed utilization.

In the second experiment pigs fed a barley diet during the growing period grew as well as those fed a wheat-barley (86:14) or barley plus acidulated fatty acid diet. Pigs fed a wheat-barley diet from 22 to 100 kg had better feed efficiency than those fed a wheat-barley grower followed by a barley finisher diet or those fed barley throughout the test. The wheat-barley diet and the barley plus acidulated fatty acid diet resulted in fatter carcasses than obtained with barley alone.

These studies indicate that grower period growth rates equal to those on corn-soy diets may be obtained with wheat-barley mixtures and that pigs fed barley during the finishing period may gain as fast as those fed corn or wheat-barley diets but may grade better. They also indicate that the apparently superior nutritional characteristics of the corn-soy diet may be partially offset by a reduction in the value of the carcass at slaughter.

## Energy, Equipment

**"Development and Testing of an Improved Wild Rice Harvester for Northern Saskatchewan"**

R.L. Kushwaha — $11,000
Dept. of Agricultural Engineering — 1 year
University of Saskatchewan

The wild rice in Northern Saskatchewan is grown in lakes. Because of uneven ripening of the rice heads and its easy shattering characteristics, the rice is harvested using airboats with front mounted buckets by making multipasses. The harvesting efficiency of 28 to 35 percent has been obtained with these airboats harvesters with an average production of 190-196 kg/ha (170-175 lb/acre). However, the potential yield available for harvest ranges from 560 to 670 kg/ha (500-600 lb/acre). Therefore, if the harvesting system can be improved to at least double the harvesting efficiency, the production will double without increasing the area under production. Thus, the objectives of this project were to develop and test a wild rice harvesting mechanism to achieve higher rice intake.

The new harvester was designed and developed which consisted of a powered reel, rice-catching troughs and an auger assembled on a 3.05 m (10 ft) wide existing bucket supported on pontoons. Field evaluation of the harvester showed the reel was not effective in bringing the rice heads towards the collecting trays. The high speed film of harvesting action showed that the reel pushed the rice heads downward at the initial contact. A maximum of 80 percent harvesting efficiency was obtained in comparison to conventional airboat harvester. The swather type reel used here was not effective in harvesting lake rice. It is anticipated that the use of a pick-up reel will improve the action of its bats on rice heads resulting in improved harvesting efficiency.

## Economics

**"Economics of Dryland Crop Rotations in Saskatchewan"**

Robert P. Zentner — $27,000
Agriculture Canada — 1 year
Swift Current

This study examined the effects of the major economic factors influencing dryland crop rotation selections from the short-run perspective of individual producers in the Black soil zone (Parkland) at Indian Head and at Melfort, and in the Dark Brown soil zone (Prairie region) at Scott. It involved calculating levels of net farm income, cash flows, non-market income variability, amount and seasonal distribution of resource requirements, breakeven stubble/fallow yield ratios, average and marginal costs of grain production, and other performance measures. A total of 15 economic situations were examined, representing different levels of (absolute and relative) price for grains and forages, input costs (e.g., fertilizer, herbicides, energy, labor), and crop insurance.

Data from ongoing crop rotation experiments at Agriculture Canada Research Stations were used in the analysis. At Indian Head, 11 crop rotations were examined for the period 1960 to 1984. These included two 2-year wheat, three 3-year wheat, two continuous wheat, three cereal-forage, one 3-year legume green manure-wheat, and three 3-year flax-cereal rotations. In some instances, the only difference between rotations was in whether or not recommended rates of nitrogen (N) and phosphorus (P) fertilizers were applied.

At Melfort, eleven crop rotations were examined over the same 25-year period. The rotations that were studied consisted of one 2-year wheat, two 3-year wheat, two continuous wheat, two 6-year wheat-forage, one 3-year legume green manure-wheat, one 3-year and one 4-year canola-wheat, and one 6-year canola-wheat-forage rotation. As at Indian Head, the only difference between some of these rotations was whether or not recommended rates of fertilizer were applied.

At Scott, 8 crop rotations were selected for analysis during the 1966 - 1984 period. These included one 2-year wheat, one 3-year wheat, one continuous wheat, one 4-year and one 6-year canola-cereal-forage, two 3-year canola-cereal, and one 7-year fallow-canola rotation. In contrast to the other study locations, recommended rates of N and P fertilizer were applied to all crop rotations.

**"Analysis of Farm Management Decisions for Changeover from Traditional Summerfallow Intensive to New Crop Intensive Conservation Systems on Saskatchewan Farms"**

Robert J. Bens — $10,000
Biggar — 1 year

Recent research has created a flow of management information on new growing systems. The potential of the new crop intensive, water efficient, conservation oriented systems is clear. However, financial concerns make uptake of the new technology difficult for many farmers.

The objective for this study was to utilize farm business simulation techniques to examine the financial impact of changeover from tillage intensive, water inefficient systems, and to identify key problems for business planning.

A cash flow analyzer program was developed by FarmWest Management Limited of Saskatoon for this analysis. The program compares the cash flow consequences of changeover decisions based on a range of yields, prices, input costs and interest rates.

Four detailed case studies were completed for grain farms in the Dark Brown Soil Zone. A feasible business plan was developed for one of the farms.

The study results indicate that high yields and high water use efficiency do not necessarily mean that a cropping system is feasible in terms of business planning on individual farms. For example, for the Dark Brown case farm cited, the land base (2,000 ac) and debt/equity position (less than 20%), proved to be only adequate as resource base for accommodating the financial uncertainties associated with the changeover.

The main source of financial uncertainty arises from expected ranges in grain prices, inflation and interest rates. Even given very high yields based on innovative technology, these factors can combine to overwhelm the high yield potential of innovative cropping systems on individual farms. For example, the difference in net cash flow between "expected" and "downside" market factors is approximately $250,000 over 5 years for the case farm cited. With this magnitude of financial instability, the farm's creditor(s) will need to be brought into the changeover decision process, because of the necessity of formal pre-authorization of the credit which could be required should downside market factors materialize over a 5 year period.

Based on the case studies, some broad rules of thumb can be suggested with regard to the feasibility of changeover to crop intensive conservation systems in the Dark Soil Zone. Generally it will not likely be possible to establish a feasible business plan for changeover unless there is at least 2,000 acres of good land per family unit, yield target x expected price is at least $150 per acre, and debt/equity ratios are 20% or less.

**"Family Spending Study"**

Wayne Gamble — $11,800
FarmWest Management Ltd. — 1 year
Saskatoon

Family spending is responsible for a significant portion of total cash outflows on Saskatchewan farms. The general objective for this study was to assess differences in family spending priorities and decision-making for case farms in different stages of farm development and family maturity.

Case studies were carried out to isolate cash flow patterns for your beginning farmers, established farmers with family at home, and well established farmers whose family is out on their own.

The hypothesis was that major differences would be found in terms of attitudes and priorities for family spending decisions. The cases were selected from a group of farm records, clients with detailed case data for both farm and family. As expected, younger farmers were found to have less assets and a higher debt/equity ratio, and tighter cash flows, than older farmers with mature families.

The results indicate that well established farmers with mature families tend to be more satisfied with the farm as a place to live and raise a family. They consider the farm a good place to keep investing, even when farm returns are low, and even when retirement is looming on the horizon.

The young family with a farm in the initial stages of development is more likely to consider that they are "too busy" to really enjoy the farm as a place to live. There tends to be strong competition for the farmer's time among family members. This type of farm family tends to divide business and family decision-making more equally between husband and wife, although the husband still tends to retain the leadership role.

All case families demonstrated positive attitudes to work, regardless of financial or family status. A very negative attitude was evident in all cases regarding the possibility of reducing farm assets as a method of dealing with cash flow problems.

In all cases, farm financial decisions were the responsibility of the husband. Family spending was usually done on an ad hoc basis without much planning, with an abstract guideline of "we won't spend it if we haven't got it". This was true even though family spending at $15,000 - $30,000 per year, represented approximately 25% of total cash outflows, and even though all families consistently underestimated cash outflows required for family spending.

The impact of this research comes from a greater understanding of business/family decision making processes. It appears that the need to specialize skills and knowledge is in conflict with social trends to share business/family decisions. This conflict contributes to the high stress levels evident for younger farm families. Educational programs are required to focus on the interrelationships between the farm business and farm family in the context of farm management and family decision making. Development of farm management information systems which monitor business and family cash outflow is required.

**"International Durum Wheat Market: An Analysis of Alternate Forecasting Methods"**

S.N. Kulshreshtha, G.G. Storey and N.S. Dhaliwal — $10,500
Dept. of Agricultural Economics — 1 year
University of Saskatchewan

On account of an increasing stake by Saskatchewan producers in durum production, a study of the durum wheat economy was commissioned to look into developing forecasts of economic parameters of interest to producers. In

the recent years, the application of alternative forecasting methods has attracted attention for forecasting various agricultural commodity markets. However, the major emphasis of these studies has been on the livestock industry. The foodgrains industry has been mostly neglected. In this study an attempt is made to develop and evaluate four alternative forecasting models for the international durum wheat market. These methods are: econometric model, Box-Jenkins univariate model, model using the Futures market as a predictor, and the combined method. The last method uses results from more than one of the other three methods in an attempt to improve the forecasts. The purpose of the study was to find out which model (models) is (are) more appropriate to forecast important supply, demand and price components of the world durum wheat market.

Existing empirical studies of evaluation of the world wheat market have typically ignored the durum wheat. One is forced to make the supposition that economic conditions affecting the durum and nondurum wheat are similar. There exists ample evidence which shows that the production and market conditions for durum wheat are not identical to that of other wheats. The importance of forecasting world durum wheat market for the Canadian as well as for the U.S. durum wheat economies is noteworthy because, among many reasons, (1) about 80 pecent of the Canadian and about 50 percent of the U.S. total production of durum wheat is exported overseas and (2) in the recent years, Canadian and U.S. exports, together, constituted more than 90 percent of the total world exports of durum wheat.

The study concludes that no one individual forecasting model performed consistently better than the others in forecasting the key economic variables of the durum wheat economy. The econometric model generally performed better in the case of export demand variables where the observation are stochastic in nature. The Box-Jenkins model seemed to produce better forecasts for stocks and prices where the subsequent observations are correlated. The future market method could not provide satisfactory forecasts. This may be attributed to the absence of an independently organized futures market for durum wheat. Thus the results of the present study suggest that an application of a diversified strategy to forecasting is preferable. The evaluation results for the combined model also support such a strategy.

# Objectives of Current Projects

## Cereal Crops

**"Biology and Control of the Orange Wheat Blossom Midge in Saskatchewan"**

J.F. Doane, C. Gillott — $13,500
Agriculture Canada
Saskatoon

In 1983 orange wheat blossom midge, *Sitodiplosis mosellana*, was discovered in NE Saskatchewan. The subsequent spread of wheat midge and resultant damage to wheat crops in the province (30 million dollars in 1983) emphasize the need for a midge control program. Although insecticides will be necessary for control during severe infestations, ultimately, natural predators may be the most useful agents for long-term maintenance of low-density midge populations. Carabids are known to be important biocontrol agents of wheat midge in Europe and of other insect pest species throughout the world. Therefore, it is logical to suggest that carabids may perform a similar role as predators of wheat midge in Saskatchewan.

The objectives of this study are: 1) to determine the species complex of potential carabid (ground beetle) predators of wheat midge, identify and quantify the most important species and map their seasonal distribution in relation to wheat midge activity; 2) to determine the effect of insecticides on the dominant species of carabids so that, if practical, those insecticides giving the best midge control, but having the least impact on predators, may be selected; 3) to determine by serological tests which species feed on wheat midge larvae in the field.

The goal of this project is to provide information of use in the development of an integrated control program for wheat midge that employs both insecticides and natural control agents. Such a program could result in substantial savings for Saskatchewan farmers.

## Special Crops

**"Scentless Chamomile Control Program"**

G.G. Bowes — $8,800
Agriculture Canada
Regina

Several herbicides were tested for the control of scentless chamomile. Major habitats which supported the growth of scentless chamomile and insects associated with the weed were identified. Glean, Torch, Lontrel and 2,4-D and DPX T6376 controlled seedlings growing in wheat. At rates, which exceeded wheat tolerance, Tordon 22K, Tordon 101 and DPX Y6376 controlled biennial/perennial plants growing in non-cropland areas. Seed did not set in the herbicide treated areas. The main non-crop areas where scentless chamomile maintained its population were transition areas between fields and sloughs and disturbed areas along roadsides. From these areas, it's assumed, the weed spreads into cropland. Solid stands of scentless chamomile attracted large numbers of insects which were general feeders. These insects did not influence the size of the scentless chamomile population.

**"Development of a Bleaching Resistant Dry Green Cotyledon Pea for Saskatchewan"**

A.E. Slinkard — $10,000
Crop Development Centre
University of Saskatchewan

A bleaching resistant dry green cotyledon pea adapted to Saskatchewan could increase pea production by 10,000 hectares. Sixty-one advanced selections were evaluated for seed yield, maturity, seed size and plant height at Saskatoon in 1984. Twenty-five of these selections outyielded Trapper, the most widely grown dry yellow cotyledon pea variety in Saskatchewan (60,000 acres or 24,000 hectares in 1984). The best of these selections will be grown in replicated yield trials at Saskatoon and Hagen in 1985.

## Forages

**"Fertilizer Requirements of Grazed Seeded Grass Pastures and the Subsequent Effects on Nutrition and Production of Beef Cattle and Subsequent Performance on Winter Feed"**

R.D.H. Cohen and S.B.M. Wright — $30,000
Dept. of Animal & Poultry Science
University of Saskatchewan

Grazed pasture is a valuable resource for the cattle industry in Saskatchewan and the indications are that this resource is being inefficiently utilized. Inadequate soil nitrogen levels restrict both plant growth and nutritive value, thereby reducing carrying capacity and consequentiy the amount of beef produced from these pastures. This project will investigate the economic viability of pasture fertilization and the accompanying increase in pasture productivity.

Four levels of nitrogen fertilizer (0, 50, 100, and 200 kg N/ha) were applied annually to two replicates of 32 year old brome (*Bromus inermis*)/crested wheatgrass (*Agyropyron cristatum*) pasture. The two hectare pastures were grazed by minimum of five pregnant yearling heifers in a put and take system.

Soil samples collected before fertilization and at the end of each of two grazing seasons showed an increase in surface soil nitroen with increasing fertilizer rates only following the second grazing season. Soil nitrogen accumulation below a soil depth of 15 cm occurred only at the highest fertilizer rate. Every two weeks the heifers were weighed and pasture quality, availability and utilization determined.

A reduction in pasture productivity was observed in the second year as a result of low precipitation. In 1983, the number of animal grazing days (AGD), total forage production (TFP), and total liveweight production (TLP) increased curvilinearly with increasing fertilizer application. Pasture quality also increased with increasing fertilizer rates as is indicated by a linear decline in the forage required per unit liveweight produced. Maximum AGD (292 days/ha) occurred at 200 kg N/ha, TFP (5659 kg DM/ha) at 120 kg Nha, and TLP (200 kg/ha) at 150 kg N/ha. In 1984 all productivity measurements tended to increase in linear fashion with the maximum AGD (154 days/ha), TFP (3094 kg DM/ha), and TLP (122.1 kg/ha) all occurring at 200 kg N/ha.

## Horticultural Crops

**"Using Etiolation as a Pretreatment in the Propagation of Saskatoon Softwood Cuttings"**

S.H. Nelson — $4,200
Dept. of Horticulture Science
University of Saskatchewan

Four cultivars of saskatoon berry were etiolated by excluding light to the developing stems and foliage rather than to the base of the shoot as commonly practiced. The etiolated (yellowish) foliage was regreened by indirect (north) light before the cuttings were taken. The number of roots per cutting and the root mass was considerably enhanced by etiolation in combination with a strong auxin treatment when rooted under intermittent mist outdoors. The saskatoon, being a shy-rooter, transplants better as the root mass increases. Anoxia (replacement of air with nitrogen gas) for short periods, although not significantly better, seemed to enhance rooting and should be further investigated. This treatment failed to produce lateral bud break and regrowth either as a pre- or post-rooting treatment to the cuttings.

Truncating the cuttings, pre- and post-rooting treatments of the cuttings with ethylene gas (50 ppm), or treatments with cytokinin and gibberellin failed to bring about lateral regrowth and the ethylene gas was particularly severe on the cuttings. Post rooting cold storage (2 degrees C) treatments for six weeks or longer showed promise in causing regrowth. Earlier forcing, etiolation, and rooting should allow sufficient time for the cold treatment and still transplant the same year.

**"Inhibitory Effects of Green Foxtail (Setaria viridis L.) On Onion Plants"**

D.H. Dabbs and P.L. Englund — $12.000
Department of Horticulture Science
University of Saskatchewan

Experimental methods have been devised to attempt to determine if green foxtail plants possess a toxic substance that would explain the devastating effect they have on developing onion plants.

Significant results were achieved in the greenhouse and growth chamber when onions were "watered" with leachate collected from green foxtail pots. These treatment onions weighed approximately 40% less than control onions raised under the same conditions.

Results of a field trial run in 1984 show green foxtail reducing the growth on onions significantly, even at the low density of one green foxtail plant every 1.0 m in a row of onions. Results were similar among 4 different onion cultivars.

If green foxtail does exude a plant toxin, like we suspect it does, it would become even more important to rid onion fields of this weed. A pre-emergent herbicide registered for onions to prevent its emergence would become very important. The

uncertainty of obtaining an adequate level of weed control is one reason why Saskatchewan growers are producing less than 1% of onions consumed here. We believe a more complete understanding of the effects of green foxtail on onions is needed in the search for more suitable herbicides.

## Ruminants

**"Potassium and Electrolyte Balance in Rations for Dairy Cows and Calves"**

D.A. Christensen — $16,000
Dept. of Animal & Poultry Science
University of Saskatchewan

This project is being carried out to develop ways of alleviating acidosis in high producing lactating dairy cows and in rapidly growing calves.

Insufficient information is available on proper electrolyte (sodium, potassium and chloride) nutrition of ruminants and pre-ruminant calves. It is necessary to obtain further information of minimum and maximum levels of these three elements in the ration and to determine the effect of interrelationship of these electrolytes. Also required is information on the requirements for these nutrients under different physiological states (lactation, pregnancy, rapid growth). One practical pay-off for this work would be evaluation of potassium in its various forms as a replacement for sodium as a buffer in rations for both calves and dairy cows. Cations (positively charged ions) and anions (negatively charged ions) and their ratio has been shown to affect rate of gain, feed-gain ratio and amino acid utilization in poultry and swine. As yet, no information on cation-anion balance in ruminants is available. These projects with growing calves and lactating dairy cows are being carried out to compare and evaluate sodium and potassium sources and to evaluate the effects of these two cations in relation to anion content of the ration. The effects of supplying insufficient amounts or an improper ratio of sodium and potassium is thought to be a reduction in feed intake and an impairment of both growth and milk production.

**"Intensification of Sheep Production Under Prairie Conditions"**

N.C. Rawlings, W.E. Howell — $30,000
Western College of Veterinary Medicine
University of Saskatchewan

This project is designed to increase ewe productivity by enhancing fertility and breeding ewes 3 times in 2 years. It is also an aim to spread the supply of lamb across the year by breeding ewes at spaced and predetermined times throughout the year. A scheme is being evaluated whereby a flock of ewes of breeds found on the Prairies is split in two. The 2 groups are bred 3 times in 2 years, with breeding spaced 4 months out of phase, using estrous synchronization, day length manipulations and a variety of other techniques. A thorough examination of the economics and managerial requirements for intensified production are an integral part of the study. The project was initiated in August of 1982 and the intensive flocks have now completed at least 1 production cycle (3 lambings, 2 years). Results have been encouraging but have also emphasized the need for rigid culling, excellent nutrition and selection of young healthy and prolific ewes.

**'B-Carotene Nutrition and Reproduction in Beef Cows: Continued Studies"**

L.G. Greenberg, B.D. Murphy and B. Laarveld — $12,800
Dept. of Animal & Poultry Science
University of Saskatchewan

B-Carotene is normally only considered for its nutritional importance as a precursor of vitamin A. With the introduction of synthetic vitamin A in animal feeds, B-carotene was no longer considered necessary. Recently it has been proposed that B-carotene by itself is an essential nutrient and is important for normal reproduction in cattle. The action of B-carotene in this case is totally independent of vitamin A. Typical wintering rations for beef cattle in Saskatchewan provide little B-carotene, thus potentially impairing reproduction.

Many of the early studies were done in Europe. These studies suggested that B-carotene is important for maintaining levels of the reproductive hormone progesterone in the blood circulation. Progesterone is produced in the luteal cells of the ovary. The objective of this study was to obtain ovarian luteal cells from heifers fed high and low B-carotene diets and to test the ability of these luteal cells to produce progesterone in the laboratory. Seven heifers were maintained for several months and observed for estrus activity. Four heifers were fed a B-carotene deficient diet and three heifers a B-carotene adequate diet. Heifers were slaughtered when in the luteal phase of the cycle. Ovaries were collected immediately after slaughter and transported in buffer on ice to the lab. Luteal cells were then harvested for the in vitro studies. Rates of progesterone production were measured under a variety of incubation conditions.

The results of the study indicate that there was no difference between ovaries from heifers fed high or low B-carotene diets with respect to progesterone production. These results agree with findings from a previous study where B-carotene did not improve reproduction in beef heifers severely deficient in B-carotene.

We conclude that consideration of B-carotene as a ration ingredient to promote fertility does not appear necessary.

## Non-Ruminants

**"Quantification of the Increase in Feed Consumption Due to Social Facilitation"**

Nora J. Lewis — $15,000
Dept. of Animal & Poultry Science
University of Saskatchewan

Piglets often experience a lag in growth following weaning. This lag is neither productive nor a normal result of weaning and should be eliminated. One of the methods for reducing this lag which is presently being studied is the use of the piglets'

own behaviour to increase feed consumption through social facilitation. Social facilitation of feeding is the strong tendency to eat, experienced by a pig when other pigs are eating. In order to manipulate the behaviour of the piglet using social facilitation the characteristics must be determined, this was the objective of the study. The characteristics of most importance where phrased as questions: 1) Does the impact of social facilitation increase as the number of feeding pigs increases? 2) Is resting also facilitated, will feeding piglets tend to rest if other pigs are resting? 3) Does social facilitation increase overall feed consumption or only increase feed consumption at a given time, the pig compensating by eating less at another time?

The answers to these questions should help in determining the number of pigs/pen and the number of feeder spaces necessary to optimize the increase in feed consumption due to social facilitation. The final aim of this project and other related research will be to reduce or eliminate the lag in growth rate following weaning.

**"A Feeding Regime for Early Weaned Piglets Based on the Natural Behaviour of the Piglet"**

Nora J. Lewis
Dept. of Animal & Poultry Science
University of Saskatchewan

$23,000

Early weaned piglets are artificially weaned at a time when milk is still a large part of their intake and are placed on a diet composed completely of solid feed. These piglets, inexperienced with controlling feed intake, may be over consuming or under consuming feed, causing digestive problems, scouring and diminished growth rate. The use of a controlled feeding system for the first week following weaning could solve these problems by teaching the piglets how to control their feed intake properly. A previous study used an operant conditioning apparatus to determine the optimum number, size and distribution of meals based on the hunger and satiety of the piglet. The objective of this study will be to test this feeding regime under commercial conditions to determine if this feeding system will increase the feed consumption of early weaned piglets while reducing scours due to digestive problems.

Following the results of this test it should be possible to advise producers who are having problems with a lag in growth rate following weaning on whether or not a meal feeding program will reduce this problem substantially.

**"Dietary Enzyme Supplementation as a Method of Improving the Nutritional Value of Cereal Grains"**

H.L. Classen, G.L. Campbell and R.E. Salmon
Dept. of Animal & Poultry Science
University of Saskatchewan

$30,000

Carbohydrate gums in several cereal grains, such as barley, have a detrimental effect on the productivity of poultry. The dietary addition of enzymes capable of breaking down these gums is known to improve the nutritional value of the grain, but many enzyme sources are very costly and therefore cost prohibitive. Recently research trials have provided evidence that a crude enzyme source (Zymo-Best) may be cost effective in breaking down the gums (B-glucan) found in barley and oats. The objectives of the present study were: 1) to investigate the practical use of this enzyme source in providing the nutritional value of cereal grains for poultry; and 2) to study the factors affecting stability of the enzyme and establish a technique to quantify enzyme activity.

Two trails were conducted to investigate the use of the enzyme source in diets for broiler chickens. In both trials enzyme supplementation markedly improved the growth and feed efficiency of broilers fed hulled or hulless barley. Maximum performance was obtained when 25,000 ppm of the enzyme source was added, but a range of 125 to 250 ppm was adequate to produce the majority of the improvement in performance. The results also demonstrated that enzyme supplementation was beneficial throughout the broiler production cycle and in diets which were pelleted and contained anticoccidial agents and growth promotants. From this research, it can be concluded that enzyme supplementation of barley diets for broiler chickens is commercially applicable. Results from 3 trials with turkeys were not consistent. In an initial battery trial, enzyme supplementation of turkey diets containing wheat, hulled barley, hulless barley or oat groats did not improve growth rate or feed efficiency regardless of level of enzyme addition (0, 100, 200, 300, 400, 800 or 1600 ppm). In a second trial, enzyme supplementation numerically improved the performance of turkeys fed hulless barley or oat groats while in a third trial performance was significantly improved from 0 to 4 weeks of age for turkeys fed hulled or hulless barley. Production parameters for the remainder of the cycle in the latter trial (4 to 13 wks) were unaffected by enzyme supplementation but the final data for the entire experimental period still reflected the superior early performance. Additional research in turkeys is required to determine the reason for the age effect on productivity improvement due to enzymes. In addition; more data is required before a definite statement can be made about the commercial use of this enzyme source in barley and oat diets for turkeys.

A gel diffusion assay was found to be a rapid, simple and reliable method of establishing enzyme activity. The assay demonstrated that at least some Zymo-Best activity is retained in the gastrointestinal tract; this supports the improved performance seen in chicken growth trials. This enzyme source was relatively stable to pH with little loss in activity after 10 min. exposure to pH2. Exposure of Zymo-Best to 60 degrees C did not alter enzyme activity but at higher temperatures marked loss in activity was noted. This is of concern since most poultry diets are steam pelleted, a process during which temperatures greater than 60 degrees C can be reached. Analyses of the enzyme activity of diets used in experiment 2 revealed a 20 to 36% loss in enzyme activity as a result of pelleting. The beneficial effect of the enzyme supplement in that trial was obvious but variability in the temperature of pelleting and the time diets are exposed to high temperature makes

monitoring of enzyme activity in pelleted diets essential. The gel diffusion assay would appear appropriate for this monitoring.

The major benefits of this study are the potential reduction in feed costs as a result of the use of cheaper feed grains and the improvements in poultry productivity. These factors would act to improve the competitive advantage of Saskatchewan poultry producers. In the past, Saskatchewan producers have had to pay higher feed costs than their eastern Canada counterparts. This, despite the fact that Saskatchewan is a major site of grain production. Difficulty in obtaining feed wheat and generally high prices have influenced this problem and the use of increased amounts of barley should have a marked effect on poultry production costs. Information on the effective utilization of cereal grains such as hulless and hulled barley in poultry diets may improve their export market potential because sales for poultry feed represent an important component of the feed grain market.

**"Evaluation of the Bioavailable Biotin from Saskatchewan Feed Ingredients for Pigs"**

R. Misir and R. Blair — $8,000
Dept. of Animal & Poultry Science
University of Saskatchewan

The objectives of this study were to 1) determine the total biotin content of swine feed ingredients originating from various geographical regions of Saskatchewan, and 2) estimate the bioavailable biotin from representative ingredients from each category (grain, protein supplement) using growing-finishing swine. Results to date suggest that the biotin content of a given ingredient might vary with the region of origin. The significance of this observation will be interpreted in conjunction with data from the remaining biotin assays and also estimates of bio-available biotin. This project is rescheduled for completion by Fall 1985.

**"Improved Swine Barn Ventilation Systems"**

E.M. Barber — $30,000
Dept. of Agricultural Engineering
University of Saskatchewan

The objective of this three-year project is to evaluate the performance of several different types of barn ventilation equipment. A total of eight farrowing rooms, two dry sow rooms, and two weanling rooms, all at the Prairie Swine Centre and all closely resembling typical commercial barns, are included in the study. Treatments involve three fan types (single-speed, two-speed, and variable speed) from five manufacturers, seven different fan controllers, two air-inlet systems, and two air recirculation systems. Comparisons are being made based on energy costs, equipment costs, ease of installation and of operation, maintenance requirements, and the quality of environment control achieved within the barn airspace.

The results of this project will benefit livestock and poultry producers by providing guidance on the selection and operation of currently available ventilation equipment. Limitations and special features of particular ventilation systems will be identified so that individual producers may choose the system best suited to their individual needs, experiences, and abilities. Guidance also will be provided to manufacturers, distributors and installers of ventilation equipment that should result in better ventilation systems for Saskatchewan producers.

**"Oxalic Acid Concentrations in Saskatchewan Feeds"**

N.F. Cymbaluk — $7,700
Dept. of Animal & Poultry Science
University of Saskatchewan

Oxalic acid is produced during normal growth of plant tissues. Oxalic acid can bind with certain minerals both in plant material and in animal tissues. The important minerals bound by oxalate are divalent cations such as calcium. Calcium bound in this way is unavailable to the animal and therefore high or moderate intakes of oxalate can induce a state of calcium deficiency. Calcium is needed for bone formation and maintenance in all livestock. Forages grown in temperate climates such as in Saskatchewan were not thought to contain significant amounts of oxalate. However, our studies with ponies have shown that calcium absorption from certain forages was lower than expected. Subsequent evaluation indicated that the oxalate concentration may have been the antagonistic factor to calcium uptake. The current study was undertaken to evaluate the levels of oxalate in locally grown forages.

A method was developed for accurately measuring oxalates in plant tissues. The forages tested for oxalate concentration have included legume, legume-grass hays, grass, native and cereal hays. The legume hays, primarily alfalfa, contained the highest average calcium (1.67%) and oxalate (0.85%) concentrations. The range of oxalate in these hays was between 0.15 to 1.76%. Legume-grass hays had lower calcium (1.2%) and oxalate (0.63%) concentrations but the range of oxalate concentrations was between 0.22 to 1.85%. Grass and native hays had an average of 0.54% calcium and 0.33% oxalate. Cereal hays contained an average of 0.36% calcium and 0.31% oxalate. Two moles of oxalate are estimated to bind with 1 mole of divalent cation. Based on this prediction, the available calcium content in 80% of grass and cereal hays evaluated to date was below 0.20% and below 0.10% in 33% of these sampled forages. These forages would be poor sources of calcium for livestock.

Furthermore, calcium availability from alfalfa, brome, slough and oat hay was tested using ponies. The available calcium concentrations were estimated to be 0.83% for alfalfa, 0.48% for brome, 0.48% for slough and 0.14% for oat hay. Calcium digestibilities were 72, 69.5, 61.7, and 55.3% in these hays, respectively. Subsequently, chopped alfalfa, barley, and oat hays were evaluated. Negative calcium balances were obtained when both barley and oat hays were fed. The available calcium concentrations were estimated at 0.22% indicating that this amount of calcium was insufficient at maintaining calcium homeostasis in these mature animals.

**"The Feasibility of Utilizing Saskatchewan Reared Honeybee Queens in Commercial Honey Production"**

Tom Taylor and Steve Clifford — $16,000
Nipawin

The main objective of this project is to establish a greater degree of self-sufficiency in the commercial honeybee industry of Saskatchewan. Traditionally, beekeepers in Saskatchewan who winter their colonies replace their annual winter loss with bees and queens purchased in the United States. However, the northward migration of the Africalized honeybee Apis mellifera aclonsonni, is posing a double threat to these supplies. The honeybee itself is expected to have a profound effect in the bee-rearing belt of the southern states. The second threat is caused by the varroa mite being carried by these bees. This mite which had been unknown in North America, is generally regarded as the worst honeybee pest in existence.

This project is evaluating various techniques of Queen/brood transfers to determine the most efficient method in terms of success and how it fits into the schedule of commercial honey production. The timing of the transfers is varied to determine if it can be more effectively managed within existing time constraints.

Events in the United States are going to require that Saskatchewan honey producers become more self-sufficient. The results of this work should assist in this goal. As well, through improved queen management it should be possible to improve the honey production of over-wintered colonies.

## Land, Air, Water

**"Effect of Leonardite"**

Zoheir M. Abouguendia — $15,000
Saskatchewan Research Council
Saskatoon

Preliminary field study was conducted to investigate the effect of leonardite, a naturally oxidized lignite, on soil characteristics and forage yield. Four levels of leonardite (0, 1, 2 and 3 kg/$m^2$) were applied to a very severely saline site located south of Floral, Saskatchewan, in early May 1984. Soil and plant samples were collected for chemical analysis three months after the leonardite application.

Leonardite application have resulted in some measurable changes in soil properties including concentrations of water-soluable ions, exchangeable cations and available nutrients. However, only a few of the detected changes were statistically significant. Some of the changes are beneficial, e.g. reduction in salinity levels. The reduction in salinity levels in this study, though, was much smaller in magnitude than that reported in the literature for leonardite and similar material. This was attributed to the lack of adequate precipitation during the study period, the extremely high initial salinity level, and the possible masking effects caused by natural upward movement of salts in the soil.

The two heaviest leonardite treatments appeared to have detrimental effects on plant growth. This may have been due to the noted reduction in the level of available nitrogen, possibly resulting from temporary immobilization of inorganic nitrogen in the soil. The plots receiving the lowest leonaradite application rate produced 16% greater yield than the untreated plots. This difference, however, was not statistically significant. Nutritional quality of the plant material was not affected by any of the treatments.

The above assessment is preliminary in nature since it is based on data collected from one experimental site during a season characterized by an abnormally low precipitatin condition. Further studies are planned including resampling of the 1984 site and establishing another experimental site in 1985.

**"Groundwater Irrigation"**

J.A. Gillies — $12,000
Dept. of Agricultural Engineering
University of Saskatchewan

A program of research to assess the feasibility of using groundwater from deep aquifers on light soils for irrigation was started during 1981 at the University of Saskatchewan.

The specific objectives of this research are:

a. to assess potential changes in response of the source aquifer.
b. to assess the mechanism and degree of transport of soluble salts and relate to changes in the soil salinity balance.
c. to monitor changes in water quality of the source and the surficial aquifers.
d. to monitor crop production and relate to the changing salinity status of the soil

Two irrigators are co-operating by permitting their sites to be monitored on a long-term basis.

One site is located south-west of Donavon, Saskatchewan and consists of a center pivot system on a quarter section being supplied at a rate of 44 L/s from the Tyner Valley Aquifer. This site had been irrigated for one year prior to the start of the research and has been expanded to include three additional quarter section center pivot systems.

The second site is locted south-east of Watrous, Saskatchewan and consists of a center pivot system on a quarter section being supplied at a rate of 47 L/s from the Hatfield Valley Aquifer. This site had been irrigated for two years prior to the start of research and has been expanded to include three additional quarter section center pivot systems.

The experimental design consists of:

a. recording water levels in the source aquifer.
b. recording pumping rate, and duration of system operation.
c. sampling soils, and monitoring changes in salinity status, water holding characteristics, and organic matter content.
d. collecting water samples from source and surficial aquifers.

e. analyzing water quality — source and surficial aquifers.
f. monitoring land treatment, cropping practices and production as determined by the irrigator.
g. conducting an annual aquifer evaluation test.
h. measuring rainfall depth and irrigation application.

A recent reconnaissance survey indicates that in Saskatchewan there may be a potential for irrigation development of approximately 70,000 ha supplied from groundwater sources .

Groundwater pumping for irrigation occurs at very high rates and is seasonal. The effect of such withdrawals on aquifer characteristics and on the aquifer's ability to recover is not known. Should irrigation withdrawals exceed the safe yield of the aquifer, new regulatory procedures and water management techniques will be required.

The effect of using relatively poor quality water for crop production may alter the soil salinity balance. Monitoring the changes in soil salinity status during irrigation will provide information upon which to base management practices.

Many rural communities and extensive livestock operations collect and store wastewater in lagoons. In Saskatchewan, experience has proven that the evaporation loss from many lagoons is generally not sufficient to balance the annual inflow, necessitating the construction of larger structures or draining the lagoon. Neither of these alternatives is desirable. Consequently, the practice of irrigating with lagoon effluent has been considered and investigated. Since the quality of lagoon effluent is similar to groundwater (salinity), the results obtained monitoring soil salinity under groundwater irrigation may be directly applicable to research on irrigation with wastewater.
The quality of water in surficial aquifers can be subjected to potential contamination from the percolating irrigation water. Superimposing additional recharge water on these aquifers from irrigation will result in elevated water levels. The effect on water quality of surface streams receiving discharge from the surficial aquifers requires assessment, particularly those streams traversing provincial and international boundaries. Elevated water tables will also tend to increase the surface area and the rate of flow from saline seeps.

## Miscellaneous

**"Strain Improvement Approaches in Zymomonas Mobilis, Indentification of a Molecular Barrier Against Genetic Exchange with Escherichia Coli and Isolation of a Noninhibitory Strain"**

George G.Khachatourians $9,000
and Tom L. Haffie
Dept. of Applied Microbiology and Food Science
University of Saskatchewan

Production of transportation fuel additives, such as ethanol from agriculture biomass and dairy and food industrial wastes is an important biotechnological research challenge. Our objective has been to take the naturally occuring bacterium *Zymomonas* and through applied genetical research manipulate its makeup to construct novel hybrid strains, to simplify the conversion of non-utilizable substrates to fuel-alcohol.

We have completed our studies on hybridization between whey sugar degrading *E. coli and Zymomonas* by conjugation. We have isolated plasmid DNA from both bacteria to be used for *in Vitro* genetic engineering and transformation of other catabolic genes.

We have also identified the natural barrier in *Zymomonas* interfering with *In Vivo* genetic hybridization with other micro-organisms. In addition, we have isolated improved strains which lack this mechanism of interference. This system offers several unique advantages including improved genetic exchange and hybrid bacteria construction and co-culturing with other substrate degradative micro-organisms for alcohol fermentation.

**"High Temperature Fermentation of Straw"**

Douglas E. Caldwell $11,000
Dept. of Applied Microbiology and Food Science
University of Saskatchewan

Thermophilic bacteria have been isolated to improve the economics of fermentation and create new markets for agricultural residues, such as flax straw, which cannot be returned to the soil or used as feed. Successful completion of the objectives will provide a new, more cost effective, means of converting agricultural residues and non-crop plants to sugar and/or fermentation end products such as ethanol (gasoline additive) and butanol (diesel fuel additive). The process could potentially be carried out on individual farms, in co-operative processing facilities, or industrially. The lignin portion of the feedstock will be retained and added to soil. This will conserve soil organic matter (humus) while harvesting the energy present in cellulose (which is otherwise lost when agricultural residues are returned directly to soil and directly decomposed without microbial processing).

Thermophilic bacterial isolates were obtained from in situ soil enrichments consisting of continuously steamed soil amended with carboxymethyl cellulose at daily intervals for a period of one month. The resulting isolates were characterized and are being evaluated for the ability to hydrolyze and ferment cellulose. Results indicate that the thermal optima of the isolates are below the 78° C optimum for distillation of ethanol. The potential advantages of applying extremely thermophilic organisms include the reduction of cellulase activation energy at higher temperatures, reduced microbial contamination, thermal self-sufficiency, continuous distillation of volatile fermentation end products, and elimination of pretreatment steps. Due to the high maintenance rate of extreme thermophiles, the isolated enzyme will be more effective than cell cultures in achieving efficient saccharification. Thus the economic feasibility of using the isolated cellulase enzyme system, as opposed to cell cultures, may be determined in future studies.

# Saskatchewan Agricultural Research Fund

## Financial Statements

**For the year ended March 31, 1985**
**Office of the Provincial Auditor**
**Regina, Saskatchewan**

# Auditor's Report

To the Members of the Legislative Assembly
Province of Saskatchewan

I have examined the balance sheet of the Saskatchewan Agricultural Research Fund as at March 31, 1985, and the statement of revenue, expenditure and fund balance for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances.

In my opinion, these financial statements present fairly the financial position of the Fund as at March 31, 1985, and the results of its operations for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

W.G. Lutz, F.C.A.,
Provincial Auditor.

Regina, Saskatchewan,
April 25, 1985.

**Statement 1**

# Saskatchewan Agricultural Research Fund
# Balance Sheet
# March 31, 1985
**(with comparative figures at March 31, 1984)**

| | 1985 | 1984 |
|---|---|---|
| **Assets:** | | |
| Cash in bank | $ 7,601 | $ 908 |
| Investments - at costs (Schedule 1) | 3,682,843 | 3,743,457 |
| Accrued interest receivable | 98,828 | 96,125 |
| | $3,789,272 | $3,840,490 |
| **Liabilities and Fund Balance** | | |
| **Liabilities:** | | |
| Grants committed | $ 534,182 | $ 582,162 |
| Accounts payable | 1,658 | 2,112 |
| | 535,840 | 584,274 |
| **Surplus:** | | |
| Capital funds (Note 4) | 3,253,432 | 3,256,216 |
| | $3,789,272 | $3,840,490 |

*(See accompanying notes to the financial statements.)*

**Statement 2**

# Saskatchewan Agricultural Research Fund
# Statement of Revenue, Expenditure and Fund Balance
# For the Year Ended March 31, 1985

| | 1985 | 1984 |
|---|---|---|
| **Revenue:** | | |
| Investment interest | $ 433,751 | $ 420,202 |
| Total revenue | 433,751 | 420,202 |
| **Expenditure:** | | |
| Grants committed during the year (Note 5) | 430,658 | 438,712 |
| Board expenses | 4,219 | 4,382 |
| Printing costs | 1,658 | 3,408 |
| Total expenditure | 436,535 | 446,502 |
| Excess of expenditure over revenue | (2,784) | (26,300) |
| Fund balance, beginning of year | 3,256,216 | 3,282,516 |
| Fund balance, end of year | $3,253,432 | $3,256,216 |

*(See accompanying notes to the financial statements.)*

# Saskatchewan Agricultural Research Fund
# Notes to Financial Statements
# March 31, 1985

**1. Accounting Policies**

These financial statements are prepared in accordance with generally accepted accounting principles.

**a) Grant Commitment**

Grant commitments are recorded as an expenditure of the Fund at the point in time the Saskatchewan Agricultural Research Fund Board approves the grant. Grants committed but not paid at the year end are reflected as a liability on the balance sheet.

**2. Related Party Transactions**

**a) Costs Borne by Other Agencies**

In accordance with established government practice, the Saskatchewan Agricultural Research Fund has not been charged with any occupancy costs and no provision for such costs is reflected in these financial statements. These costs together with certain general administrative and employee benefit costs are absorbed by various departmental appropriations.

**3. Incorporation**

The Saskatchewan Agricultural Research Fund was incorporated under The Agricultural Research Funding Act, Chapter A-14.1, 1978 Revised Statutes of Saskatchewan. This Act came into force by proclamation of the Lieutenant Governor on June 15, 1979. The Saskatchewan Agricultural Research Fund is a capital fund from which grants are made to individuals, corporations, co-operatives, partnerships, associations or other organizations for the purpose of agricultural research in the province.

**4. Capital Funds**

This Fund was initially financed by an appropriation of $3.25 million in the year ended March 31, 1980. The intention of the Saskatchewan Agricultural Research Fund Board from the date of inception until February 2, 1984, was that only the investment income on the $3.25 million would be made available for expenditures. Effective February 2, 1984, the Saskatchewan Agricultural Research Board passed a motion "that a maximum of $20,000 from the capital fund be used for grants for the 1984-85 fiscal year." Therefore, at the comparative fiscal year-ends the capital funds would consist of:

| | 1985 | 1984 |
|---|---|---|
| Funds available for grants | $ 23,432 | $ 26,216 |
| Capital funds, not available for grants | 3,230,000 | 3,230,000 |
| | $3,253,432 | $3,256,216 |

**5. Grants Committed**

Grants committed during the year have been reduced by $14,742 (1984 - $3,888) representing prior year projects that have been terminated.

**Schedule 1**

# Saskatchewan Agricultural Research Fund
# Summary of Investments
# As at March 31, 1985

| Description | Rate | Maturity Date | Amount |
|---|---|---|---|
| Chrysler Promissory Note | 9.85 | April 2, 1985 | $ 229,730 |
| Trilon Promissory Note | 9.72 | April 11, 1985 | 19,527 |
| Canada Permanent Trust Guaranteed Investment Certificate | 15.00 | April 14, 1985 | 500,000 |
| Caisses Centrale Promissory Note | 10.15 | April 23, 1985 | 19,656 |
| Canadian Pacific Securities Ltd Promissory Note | 9.82 | May 1, 1985 | 371,504 |
| Chase Manhatten Bankers Acceptance Papers | 9.85 | May 1, 1985 | 420,358 |
| Bank of America Bearer Discount Note | 10.60 | May 6, 1985 | 24,481 |
| Canadian Pacific Securities Ltd Promissory Note | 10.33 | May 6, 1985 | 9,760 |
| Bank of British Columbia Mortgage Promissory Note | 11.25 | May 28, 1985 | 58,380 |
| Security Pacific Bank Bearer Discount Note | 11.65 | June 6, 1985 | 495,451 |
| Manufactor Hanover Bank Bearer Discount Note | 11.60 | June 13, 1985 | 29,166 |
| Canadian Imperial Bank of Commerce Certificate of Deposit | 12.00 | June 17, 1985 | 500,000 |
| Province of Alberta Promissory Note | 11.80 | June 25, 1985 | 4,830 |
| First National Bank of Chicago Certificate of Deposit | 11.625 | April 1, 1986 | 1,000,000 |
| Total Investments | | | $3,682,843 |